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# U. S. DEPARTMENT OF AGRICULTURE

FARMERS' BULLETIN No. 1297

## COST OF USING TRACTORS *on*

Corn-  
Belt  
Farms



The following series of six bulletins has been prepared under the direction of the Committee on Farm Power, appointed by the Secretary of Agriculture, to represent the Bureau of Agricultural Economics, Bureau of Public Roads, and the Bureau of Animal Industry, in a cooperative study of all phases of the farm-power problem.

Farmers' Bulletin 1295: What Tractors and Horses Do on Corn-Belt Farms.

Farmers' Bulletin 1296: Changes Effected by Tractors on Corn-Belt Farms.

Farmers' Bulletin 1297: Cost of Using Tractors on Corn-Belt Farms.

Farmers' Bulletin 1298: Cost of Using Horses on Corn-Belt Farms.

Farmers' Bulletin 1299: Shall I Buy a Tractor? (For a Corn-Belt Farm).

Farmers' Bulletin 1300: Choosing a Tractor. (For a Corn-Belt Farm).

This bulletin, which is No. 3 of the series, deals with the various items of the cost of tractor operation and the possibilities of a reduction of these costs. By a careful study of the figures presented, a good idea may be had of the probable cost of tractor operation for any Corn-Belt Farm.

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## COST OF USING TRACTORS ON CORN-BELT FARMS.

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**E**VERY FARMER who owns a tractor naturally is interested in the cost of operating his machine and in reducing that cost wherever it is possible to do so. To give accurate information that will apply to any tractor on any Corn-Belt farm is impossible, as this can only be done where complete records have been kept covering a year's operations on a given farm. However, it is possible to present information which should serve as an index or guide to the tractor owner and prospective owner. It is the purpose of this bulletin to present this information in such a way that the prospective tractor owner will be aided in judging for himself whether a machine will prove profitable on his farm.

The principal elements of cost of use, in order of their relative importance, as shown by the various investigations made at different times by the United States Department of Agriculture are as follows: Depreciation, fuel, repairs and upkeep, interest, and lubricating oil. The relative importance of these elements of cost may vary in different sections of the Corn Belt and on different farms in the same locality.

### DEPRECIATION.

The depreciation charge per year or per day of work is ordinarily determined by dividing the first cost of the tractor by its total useful life in years, or by the total number of days of work done during this time.

**First cost.**—First cost of the tractor, naturally the item to which the prospective purchaser gives the greatest thought, depends on the size, type, and make of machine purchased. Added to this may be whatever amount the owner spends for extra equipment.

The purchase of a tractor will generally necessitate the purchase of a certain amount of machinery for use with it, unless it is only to be used on the belt and the machines are already owned. At the present time (September, 1922) a 2-bottom, 14-inch tractor plow costs around \$75, a 3-bottom plow from \$100 to \$125, and a tandem disk 8 feet wide about \$75. This is the machinery which the majority of tractor owners buy. (See Farmers' Bulletin 1296, *Changes Effected by Tractors on Corn-Belt Farms.*)

The first cost of the tractor should be an indication of quality; therefore, a machine of high class workmanship and material should command a higher price than one of lower grade. The size and make will have the same influence upon the first cost as does workmanship and material. At the present time (September, 1922) the cost of tractors of different horsepower varies considerably. The approximate cost of the lowest priced two-plow machine is now about \$400, while the larger and more expensive outfits run up to several thousand dollars. The farmer who feels that he can afford to spend up to \$1,000 for a tractor will have a number of different makes to choose from.

The majority of the tractors in the Corn Belt at the present time are either two-plow or three-plow outfits, and since experience has shown these sizes to be the best for nearly all such farms, the cost of using such sizes only will be discussed in this bulletin.

Information obtained in Ohio, Indiana, and Illinois in 1920 showed that on 286 farms there were 174 two-plow machines, 104 three-plow machines, and only 8 machines of all other sizes. Including all extra equipment purchased for the tractors themselves, the average first cost of the two-plow outfits amounted to \$972, and for the three-plow outfits \$1,354. As the average length of time these machines had been owned was 21 and 25 months, respectively, it will be seen that many were purchased at prices considerably higher than now prevail.

**Life.**—In the various investigations made by the Department of Agriculture relating to tractors there has been obtained from each owner an estimate as to the probable life of his machine. The length of life, in years, as estimated by the 278 owners of the two-plow and three-plow machines mentioned above, is as follows:

- 10 estimated a life of 3 years.
- 21 estimated a life of 4 years.
- 81 estimated a life of 5 years.
- 46 estimated a life of 6 years.
- 30 estimated a life of 7 years.
- 36 estimated a life of 8 years.
- 9 estimated a life of 9 years.
- 37 estimated a life of 10 years.
- 8 estimated a life of over 10 years.

The average of these estimates is 6.6 years. This figure agrees closely with the results of other investigations made among tractor owners in the Corn Belt.

Some of the estimates of these owners may appear low, yet there are instances of operators who have considered their machines profitable after wearing them out in as brief a time as two years, under adverse soil conditions.

Tractor owners sometimes find it profitable to trade their old machines in on new models before they wear out, or to sell them to farmers who want second-hand outfits. This practice does not necessarily increase the depreciation cost. From replies received in 1920 from 1,219 farmers in the Corn Belt and Northern Great Plains States who had bought tractors four or more years prior to that time, it was found that 469 had disposed of their first machines, 35 per cent of them for cash and 65 per cent in trade, usually for new tractors. The men who had sold their machines had kept them for an average period of a little more than three years and sold or traded them for approximately half the first cost.

While the length of time these men kept their machines before disposing of them averaged only three years, a tractor can be safely counted on to give useful service for a longer time than that. Even a low-priced tractor doing a large amount of work each year may be expected to give at least five years of service if the machine is given intelligent care and kept in repair. Under adverse conditions this figure may be lower, while under favorable conditions it may be higher.

Owners and prospective owners should not place too much weight on the average performance of tractors. It should be remembered that an average figure represents various results, some of which may be normal, and some either above or below normal. It should be the object of every farmer who is operating a tractor to strive to excel any result given as an average figure whether it represents life, cost of operation, or days of use.

The information obtained in 1920 from the 1,219 early tractor owners mentioned above showed that about half of the men who bought their tractors in 1916 and 1917, one-third of those who purchased in 1914 and 1915, and one-fourth of those who purchased in 1913 or earlier were still using them for field work.

Those men who were still using their first machines for field work had owned them on an average of about four and a half years, and they estimated that the machines would last five years more.

**Depreciation charges per day of work.**—Table 1 shows just what the depreciation is per day of work for different priced machines, with different terms of life in work days. The depreciation has been obtained by dividing the first cost of the tractor by the total days of work during its life.

TABLE 1.—*Depreciation charges per day of work.*

First cost of tractor.	Total days of work during life.				
	100	200	300	400	500
	Depreciation charges per day.				
\$400.....	\$4.00	\$2.00	\$1.33	\$1.00	\$0.80
\$600.....	6.00	3.00	2.00	1.50	1.20
\$800.....	8.00	4.00	2.67	2.00	1.60
\$1,000.....	10.00	5.00	3.33	2.50	2.00
\$1,200.....	12.00	6.00	4.00	3.00	2.40
\$1,400.....	14.00	7.00	4.67	3.50	2.80
\$1,600.....	16.00	8.00	5.33	4.00	3.20

The number of years that a tractor will perform efficient service and the total number of days work it will perform in that time depends upon the work there is for it to do, the care received, soil, and the mechanical ability of the operator. Since the working life of a tractor is nearly always estimated by the farmer in terms of years, some of the figures in Table 1 may appear low to the tractor owner. By reference to Figure 1, showing the number of days work done annually by two-plow and three-plow tractors in the Corn Belt (1920 survey), it will be seen that a few of the tractors in question did less than 10 days work per year and that one-fourth of them did less than 20 days work per year. The average tractor was used for 31

days per year during its life of 6.6 years, or a total of a little over 200 days.

The cost figures given in Table 1 give no indication of the type of tractor. It should be remembered, however, that the cost of two-plow or three-plow tractors of the wheeled and the crawler type varies considerably, the latter being the higher priced. The general purpose (2-wheeled) and the ordinary (4-wheeled) tractor of equal horsepower also vary in first cost, the latter being the cheaper. Farmers' Bulletin 1300, Choosing a Tractor, discusses in detail these various types of machines.

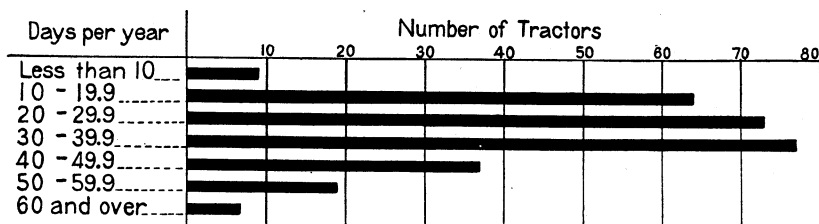


FIG. 1.—Variation in number of days tractors were used per year.

### INTEREST.

Interest being a fixed charge in the cost of tractor operation, it must be included in the annual cost. Six per cent is the rate most commonly used, the charges being made on the average investment. The average investment is found by the rule:

$$\text{Average investment} = \frac{\text{first cost} \times (\text{years of service} + 1)}{\text{years of service} \times 2}$$

The average investment computed on this basis is slightly greater than half the first cost.

In Table 2 is given the annual interest charges (at 6 per cent) for tractors costing different amounts and giving different years of service. By using the formula given above the annual interest charge at any rate can be obtained for a tractor costing an amount not given in the table.<sup>1</sup>

TABLE 2.—Annual interest charges for tractors of different price and life.

Price.	Life in years.									
	3	4	5	6	7	8	9	10	11	12
\$400..	\$16	\$15	\$14	\$14	\$14	\$14	\$13	\$13	\$13	\$13
\$600..	24	22	22	21	20	20	20	20	20	20
\$800..	32	30	29	28	27	27	27	26	26	26
\$1,000..	40	38	36	35	34	34	33	33	33	32
\$1,200..	48	45	43	42	41	41	40	40	39	39
\$1,400..	56	52	50	49	48	47	47	46	46	45
\$1,600..	64	60	58	56	55	54	53	53	52	52

### REPAIRS.

Many tractors now on the market carry the stipulation in the contract of sale that all necessary repairs needed the first year will be

<sup>1</sup> See Circular 53, Office of Secretary, "Formula for calculating interest on farm equipment."

furnished free of charge where any part broken shows defective workmanship or material. This may tend to reduce any repair bills for the first year to a negligible amount, as well as to lower the average cost of repairs for the life of the tractor.

Table 3 shows the amounts spent for repairs in one year by 278 owners of two-plow or three-plow tractors in Ohio, Indiana, and Illinois in 1920. The figures include the cost of expert labor as well as of parts.

TABLE 3.—Cost of tractor repairs.

Amount spent for repairs.	Number of owners who spent amounts specified.		Amount spent for repairs.	Number of owners who spent amounts specified.	
	Owners of 2-plow tractors.	Owners of 3-plow tractors.		Owners of 2-plow tractors.	Owners of 3-plow tractors.
Nothing.....	30	18	\$61 to \$80.....	6	7
\$20 or less.....	78	43	\$81 to \$100.....	9	3
\$21 to \$40.....	22	18	Over \$100.....	11	5
\$41 to \$60.....	18	10			

Of the 174 men who owned two-plow machines, the average age of which was 21 months, and also of the 104 men who owned three-plow machines, the average age of which was 25 months, 17 per cent had no repair expense during the year covered by the study. This lack of repair expense can not be attributed entirely to the fact that repairs were furnished free to these men, as some of them had owned their machines over a year. It would appear that by efficient operation some may have eliminated all such expense or did any necessary work themselves.

It is advisable for every farmer to do as much of his own repairing as possible. These men spent on an average 1.8 days per year for repairing. Most of the men who spent two days or more had given their machines a general overhauling. (See Fig. 2.)

## FUEL AND OIL.

The amount of fuel and oil required per day by tractors is governed ordinarily by the size of the machine. For the heavy operations, such as plowing and disking, two-plow outfits require an average of about 18 gallons of fuel per day and 4 quarts of oil, and the three-plow outfits about 23 gallons of fuel and 5 quarts of oil. By careful operation the amounts used on work where the tractor is not loaded to capacity can be reduced somewhat. There are instances, however, where an operator of a two-plow tractor has used as much as 25 gallons of fuel and 3 gallons of oil per day, which is as much or more than operators of most three-plow tractors use. When an instance of this kind occurs it is usually the fault of the operator in not having the carburetor and oiling system properly adjusted. While the three-plow outfit with its more powerful motor requires a correspondingly greater amount of fuel and oil than that required by a two-plow outfit when performing the same kind of work under identical conditions, the larger amount of fuel and oil is offset in



the greater amount of work done per day. When the cost of fuel and oil is figured on the basis of acres covered or other work done per day there is practically no difference in the fuel and oil requirements for the different sizes.

At this time (September, 1922) the price of kerosene is about half that of gasoline in the Corn Belt. The advantage of using kerosene is the low cost as compared with gasoline. Of the tractors mentioned above between 75 and 80 per cent were operated on kerosene. With the improvements that have been made in kerosene carburetors, very little trouble is experienced in burning this fuel. The amount of work accomplished per gallon when using either gasoline or kerosene is practically the same.

It should be understood that where kerosene is used the motor is started on gasoline and run until it is heated up sufficiently so that a

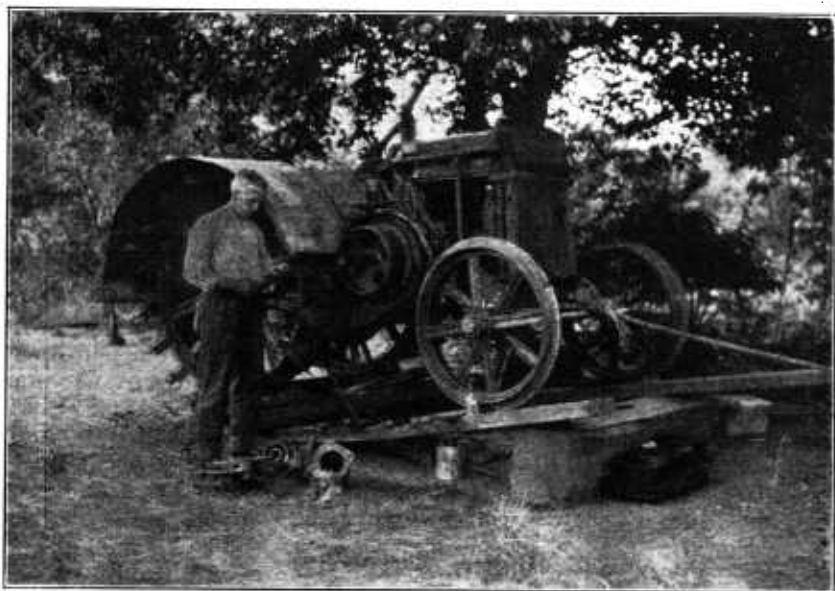


FIG. 2.—General overhauling requires from two to five days. The farmer who is capable of doing all the repair work on his tractor can reduce his repair bills materially and at the same time keep his machine in good running order.

switch can be made to the kerosene without any change in the steady flow of power. Also in shutting off the motor for any length of time it is necessary to use gasoline, so that this fuel will be in the carburetor when the motor is started again. With kerosene-burning tractors the lubricating oil in the crank case frequently becomes thin. Incomplete combustion, allowing some of the fuel to remain in the cylinders, worn cylinders or pistons, and worn or broken piston rings most frequently cause this trouble.

Some operators prefer to use gasoline, as they figure that their machines give better service and the difference is enough to pay for the added cost of using this fuel. Where either fuel is purchased in large lots a saving of 1 to 2 cents per gallon is effected, and where a large amount of work is done in a year this saving may be considerable.

The price of lubricating oil varies according to the quality used. Where oil is purchased in a large quantity rather than as needed the price per gallon is considerably less. While some operators use a cheap oil, it is generally recognized that a good quality of oil is more satisfactory and will insure a longer life to the working parts. Most manufacturers specify the kind and quality of oil to use with their machines. These recommendations are based on tests, and to obtain the best results it would be well for every operator to follow such instructions.

The amounts of fuel and oil which will be used per year by any tractor will depend on the amount of work done as well as on the size



FIG. 3.—The average Corn-Belt tractor uses about 600 gallons of fuel annually.

of the machine. A machine working 30 days per year and using 20 gallons of fuel per day will require 600 gallons for the year's work. (See Fig. 3.) If this is gasoline, costing 20 cents per gallon, the total cost for fuel would be \$120; if kerosene, at 11 cents per gallon, the cost would be \$66. The amount of lubricating oil required per year for a two-plow or three-plow tractor working 30 days per year will be 30 to 40 gallons. (See Fig. 4.) With lubricating oil costing 50 cents per gallon, the total cost for the year will be from \$15 to \$20.

### OTHER COSTS.

The items of depreciation, repairs, interest, and fuel and oil make up the greater part of the cost of using the tractor, and the possibilities of reducing the cost of use lie almost entirely in cutting down the size of these items. However, the minor costs of labor of the owner or regular help in repairing and attending to the tractor, housing, grease, taxes, and insurance must be considered if it is desired to determine the total cost of operating the machine.

**Labor in repairing and attending the tractor.**—In addition to expert labor, many farmers put in a certain amount of their own time on repairing and overhauling their machines. Some farmers have sufficient ability to do all of their own repair work. Such time spent by the owner or regular farm labor must be charged to the cost of use. When the tractor is in use a certain amount of time must be spent in filling the fuel tank, the radiator or water tank, supplying oil and grease, and making minor adjustments. When determining the cost of performing different operations this labor must be charged as a cost against the tractor or included in the labor of the tractor operator. The length of time required varies according to the size and type of machine and the attention the operator gives it. On the average a trifle less than an hour per day of use (0.95) was required in 1918 for these tractor chores on 100 Illinois farms where



FIG. 4.—Less than a barrel of oil is ordinarily required for the year's work.

tractors were owned. (See University of Illinois Agricultural Experiment Station Bulletin 231.)

**Housing.**—The cost of shelter for the tractor is the cost of maintaining the building or part thereof in which it is housed. As the tractor can be housed in a comparatively small space, the cost per year for shelter would amount to only a few dollars even if a separate building is used. (See Fig. 5.)

**Grease.**—Owing to the small amounts of grease required and the irregularity of filling the cups, together with the fact that the same source usually supplies the needs for all the farm machinery, it is difficult to obtain accurate figures as to what the cost of this item actually is. The amount used also depends on the make of the tractor and is almost too small to be considered on some machines. Only rarely would more than a pound a day be used.

**Taxes and insurance.**—The taxes on the tractor will depend upon the assessed valuation and the rate of taxation, but at the most will be only a small item. Few farmers carry insurance upon their tractors. The premium for insurance covering the full value of a two-plow or three-plow tractor will not amount to over \$4 per year.

### TOTAL COST OF USE.

Table 4 and Figure 6 show the average cost per year and per day of operating two-plow and three-plow tractors under present conditions (September, 1922). (For complete discussion of the different

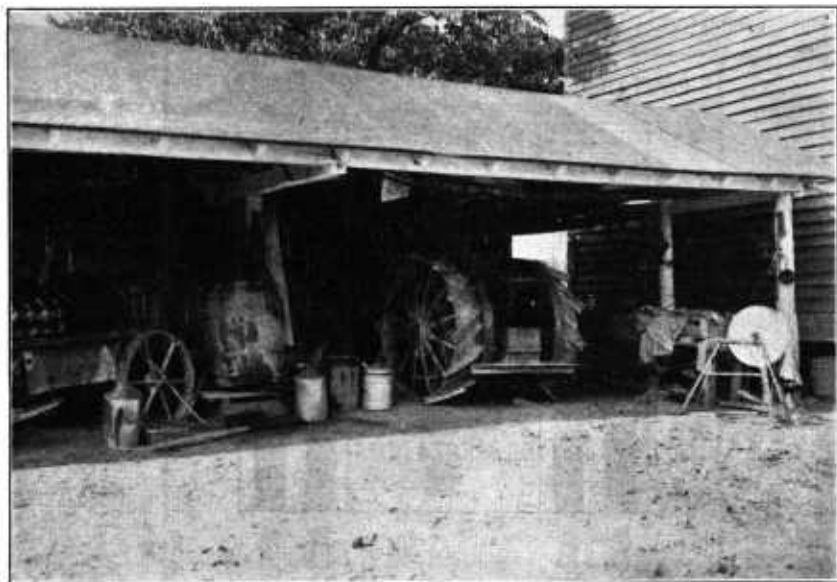


FIG. 5.—An inexpensive method of sheltering the tractor on a Corn-Belt farm.

elements of cost see U. S. Department of Agriculture, Bulletin 997.) While the cost per year and per day of operating the three-plow machines is considerably higher than for the two-plow machines, the greater amount of work done by the larger outfits, at least on draw-bar operations, makes the cost per unit of work approximately the same for both sizes.

TABLE 4.—Average cost per year and per day of work when operating two-plow and three-plow tractors.

Item.	Cost per year.		Cost per day.	
	2-plow.	3-plow.	2-plow.	3-plow.
Depreciation.....	\$78	\$129	\$2.41	\$4.53
Fuel.....	81	89	2.51	3.12
Repairs and upkeep.....	35	33	1.08	1.16
Interest.....	17	31	.53	1.09
Oil.....	18	19	.55	.67
Other costs.....	11	15	.34	.53
Total.....	240	316	7.42	11.10

Depreciation is wholly dependent upon the length of life and the first cost of the machine. The depreciation costs as shown in the figures are based on a first cost of \$500 and a life of 6.4 years for two-plow machines and of \$900 and 7 years for three-plow machines. The average life is the same as that obtained in the 1920 investigation. The depreciation costs per day of work for different priced tractors are given in Table 1.

Fuel and oil costs are dependent upon the amount of work done; and while this cost may be large for the season, it will not be out of proportion to the work done. From the daily fuel and oil requirements of each size as shown on page 7 the cost of using either gasoline or kerosene can be obtained by applying the local price of either fuel.

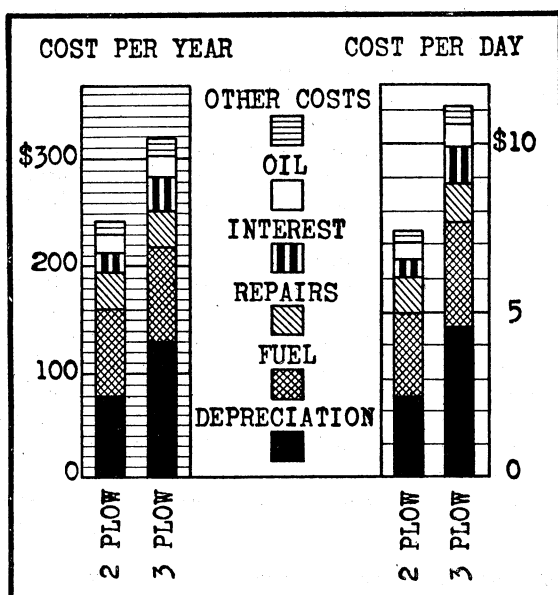


FIG. 6.—Average cost per year and per day of work when operating two-plow and three-plow tractors.

Interest charges on tractors costing different amounts and giving a different number of years service are shown in Table 2, page 6.

Repairs and upkeep costs are influenced by the care and attention given to the tractor and the ability of the operator to do his own repairing. Table 3, p. 7, shows the amount spent by different owners for repairs and labor on their machines for the year 1920.

The "Other Costs" (see p. 9) on the average will amount to not far from 5 per cent of the total cost of operating the tractor.

The annual depreciation, repair, and interest charges do not increase in proportion to the amount of work done per year; consequently the daily cost of these items will be least for machines which do the greatest amount of work. This does not mean that the tractor should be used when some other form of power would be more satisfactory, just for the sake of reducing the average daily cost.<sup>2</sup> Even though the cost per day decreases rapidly with increased use, the total cost per year must increase.

<sup>2</sup> Farmers' Bulletin 1295, What Tractors and Horses Do on Corn-Belt Farms.

## **SUGGESTIONS FOR REDUCING THE COST OF USING TRACTORS.**

**Acquiring ability to operate tractors.**—If the cost of using the tractor is to be reduced to a minimum, it is most important first of all to learn to operate it so that there will be no lack of confidence on the part of the operator regarding his ability to handle the machine under any and all conditions.

There are various ways for the owner to learn to operate his particular machine or tractors in general and to become a proficient operator he should certainly obtain instructions from some qualified source. The dealer from whom the tractor was purchased should be able thoroughly to demonstrate and show the purchaser all important details regarding repairs and operation. If the dealer is not capable of giving this service, the tractor owner should endeavor to obtain instructions from some other source.

Every tractor owner should carefully read the instruction book furnished by the manufacturer. From this he will get much valuable information concerning most phases of tractor operation. Too often the instruction book is ignored entirely and soon lost. If it is carefully saved and kept accessible, it will often prove a valuable aid.

Many manufacturers recognize that a great deal of good comes from having their machines in the hands of proficient operators. Satisfied owners are an aid to further sales. These manufacturers have therefore established the custom of conducting short courses in the care, repair, and operation of their tractors. This instruction is usually given at the factory or branch houses, and the only cost to the attendant is for travel to and from the place of instruction and his board and room while there. These courses are usually given in the winter when the farmer has time to attend, and are open to owners and prospective owners of the particular tractor.

During the past few years the subject of agricultural engineering has been given considerable prominence by various agricultural colleges, with the result that, outside of the regular courses, short courses in tractor operation are given during the winter.

Finally, there are the commercial tractor schools where, for a fee, one may receive complete instruction in the care, maintenance, repair, and operation of tractors. Such instruction not only enables one to handle his own machine intelligently but to become a repair expert as well.

The ability of an operator is dependent in a large measure on his knowledge of gas engine operation. It would be well for every tractor owner to have a simple trouble chart for gasoline engines. With such a chart before him he should be able to locate and correct many troubles.

Farmers' Bulletin 1013, *Practical Hints on Running a Gas Engine*, will be found of considerable help to inexperienced operators. This bulletin tells how to avoid or remedy the more common forms of engine trouble, gives directions for making tests to locate trouble, methods of starting in cold weather, and includes a trouble chart listing possible troubles and their remedies.

While many operators will not be able to make all necessary repairs, every operator should know how to test spark plugs, adjust

the carburetor, locate and correct trouble in the ignition system, locate and correct troubles in the fuel supply, clean out the carbon, adjust and grind valves, replace piston rings, replace gaskets, and make any other minor repairs or adjustments.

**Saving time.**—The longer a tractor is owned and the more familiar the operator becomes with it, the more time he should be able to save on the operation for which he uses it. Various short cuts will present themselves from time to time with a resultant saving in distance traveled and time spent to do a certain amount of work. Take plowing for example. The skillful operator can often handle his machine in such a way that he can plow the entire field without the use of horses. The field should always be laid out so that the time spent in turning and running with plows out of the ground will be as small as possible.

Farmers' Bulletin 1045, *Laying Out Fields for Tractor Plowing*, describes in detail various methods of laying out fields and should be a big help to anyone who has trouble in laying out and plowing regular or irregular fields.

**Combining implements and operations.**—If the tractor is powerful enough a great deal of time can be saved by pulling two or more implements at one time. When the tractor is being used for disking it may be possible to add a spiketooth harrow equal in width to the disk and do two operations simultaneously. With more powerful tractors, a disk, roller, and harrow may be used in combination. A roller and plunker or a plunker and harrow are also combined frequently. Some operators prepare and seed their ground at one operation by pulling a disk, harrow, and drill in combination.

Where two binders are available much time may be saved by hitching both to the tractor, staggered one behind the other, and having a man on each machine, the man on the forward binder driving the tractor by means of an extended control.

In order to use the tractor to the best advantage the operator should have a knowledge of efficient hitches for these different combinations of implements. It is comparatively simple properly to hitch a single implement such as a plow, disk, or binder to the tractor. However, when two or more implements are to be used in combination the problem of proper hitches may be more difficult. Many tractor companies have literature showing both simple and complicated hitches for use with their tractors and various implements. Often these hitches are explained in such a way that they can be made at home, while some are manufactured and can be purchased if desired.

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